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I, LEANNE MYNOTT, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. PQ2388 for a patent by PETER RAFFAELE and MICHAEL RAFFAELE filed on 23 August 1999.

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WITNESS my hand this
Eleventh day of April 2000

LEANNE MYNOTT
TEAM LEADER EXAMINATION
SUPPORT AND SALES

This invention relates to fluid pumps and the like. More particularly to engines that have at least two pistons. And more particularly to engines that have two pistons arrayed about a common crank main axis wherein the pistons are angularly displaced from each other so as to form what is known as a Vee configuration.

Preferably the pistons reciprocate along paths that are perpendicular to the crankshafts main axis. The pistons reciprocate in cylinders and the cylinders are capped by cylinder heads. The breathing arrangement of the device may include any suitable means including but not limited to 2 stroke and 4 stroke methods or hybrids of such.

We have disclosed such devices in our earlier applications relating to sinusoidal fluid pumps and engines. The numbers of which that we know of are PP9266, PP9306, PP9537, PQ0287, PQ0795, PQ0895, PQ0989, PQ1653, PQ1654.

We hereby incorporate these applications in this application for use herein. Some of these applications we have not yet received notification of their number and or their date of filing as determined by the A.P.T.O. Never the less we think that some may have been accepted as being filed on the 13th and 14th of the 8th 1999. Other applications we have lodged that are to do with the subject matter of the above and not listed herein we also incorporate.

One of the things we have found is that the decoupled, paired piston/s, scotch yoke devices of our invention may be balanced perfectly in that the centre of mass of the moving parts of the engine (the crank, the pistons and their members, and any interconnecting members between the cranks big end and the pistons) remains exactly stationary and centred on the main axis as the device rotates.

Attached next page is an explanation of how to balance sinusoidal scotch yoke fluid devices of our invention with at least 2 pistons. Also the Vee may be any angle from 0–18

Version

in a

A is the angle between the bores of ~~a~~ 2 cylinders vee engine

D is the angle between the big ends.

If D is set equal to 2*(A-90), the centre of gravity of the
two pistons will be found to move in a circle
so that it can easily be balanced by a counterweight
on the crankshaft.

The formula in the program assumes that the connecting
rods are sufficiently long that the motion of
the pistons is simple harmonic.

The mass of the connecting rods is ignored.

Theory

Angles are measured positive anticlockwise from the positive X a
xis

Assume the first bore is at 0 degrees.
The second bore is at an angle A degrees.

When the big end for the first piston is at 0 degrees
(so that the first piston is at TDC) the big end of the second
piston is at D degrees.

Consider the general case when the big end for the first piston
is at R
degrees
and the big end of the second piston is at D+R degrees.

Assume the radius of the crankshaft is of unit length.

The X co-ordinate of the first piston is Cos(R) measured with re
spect
to
its mean position.
The Y co-ordinate of the first piston is always zero.

The radius of the crankshaft for the second piston is also unit
length,
but in the general case we are considering, the value of the
radius projected onto the axis of the second bore is Cos(A-D-R)
Since we are only interested in variations in the position of
the C of G of the pistons, we can take the second piston to be a
t
X=Cos(A-D-R)*Cos(A)
Y=Cos(A-D-R)*Sin(A)

The C of G of the two pistons together can be taken as
X=Cos(A-D-R)*Cos(A)+Cos(R)

Y=Cos(A-D-R)*Sin(A)+0

Note that these should both be divided by 2, but this is omitted to simplify the appearance of the algebraic expressions.

It turns out that for any value of A, if we set D=2*(A-90), then the C of G of both pistons together moves in a circle and can be easily balanced by a counterweight attached to the crankshaft.

We can prove this is tha case by substituting 2*A-180 for D in the above expressions which become

X=Cos(A-2*A+180-R)*Cos(A)+Cos(R)
Y=Cos(A-2*A+180-R)*Sin(A)+0

which become

X=Cos(-A+180-R)*Cos(A)+Cos(R)
Y=Cos(-A+180-R)*Sin(A)+0

which equals

X=-Cos(A+R)*Cos(A)+Cos(R)
Y=-Cos(A+R)*Sin(A)

expanding Cos(A+R) in each case
X= -Cos(A)*Cos(A)*Cos(R)+Cos(A)*Sin(A)*Sin(R)+Cos(R)
Y= -Cos(A)*Cos(R)*Sin(A)+Sin(A)*Sin(R)*Sin(A)

simplifying we get
X=Sin(A)*(Cos(R)*Sin(A)+Sin(R)*Cos(A))
Y=Sin(A)*(-cos(A)*Cos(R)+Sin(A)*(Sin(R))

or
X=Sin(A)*Sin(A+R)
Y=-Sin(A)*Cos(A+R)

This is the equation of a point moving in a circle of radius Sin(A)

Conclusion
The motion of the two pistons together can be counterbalanced by a single mass, equal in mass to ONE piston mass rotating on a radius of Sin(A) times the crankshaft radius.
(The fact that there are actually two pistons compensates for the factor of 2 which was omitted in the expressions for X and Y above.)

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Both the primary slide and secondary slide are independently pivoted about separate axes 80 and 82.

When the axes of the primary and secondary slide are parallel the inner piston 74 does not move relative to the outer piston. When the axes are not parallel the inner piston moves relative to the outer piston as the crank rotates and the sliding members travel along the respective slides.

It will also be noted that the intermediate member is pivotably mounted on the piston, dispensing with the connecting rod. To provide the necessary degree of freedom, there is provided a separate sliding member 84 which is pivotably attached to the intermediate member 22.

The two sliders can also be move sideways along axis 86 so as to change the displacement or the compression ratio of the device. The sideways movement of the two sliders may be independent of each other.

Figure 7 shows a minor variation on the Figure 6 device in which the two sliders cannot pivot but can only move sideways.

Figure 8 shows a further minor variation of the invention having an L-shaped intermediate member 90 rotatably mounted on a slide member 92. The slide member 92 slides in slide 94 which is pivoted about axis 96. The axis 96 is not located on the sliding axis 98.

Figure 10 shows an embodiment similar to the Figure 6 device in which a linkage mechanism for a valve 101 has a rotatable follower 100 which rolls along a non-linear slot 102. Thus as the follower moves along the slot 102, the position of the valve 101 may be varied. The carrier 104 is pivoted about axis 106 to provide further control of the valve's position.

Figure 12 shows a variation of the invention and is similar to the Figure 8 device. In the Figure 12 embodiment slot 110 is arcuate and an arcuate shaped follower 112 is provided to slide in the slot 110. The carrier 114 is pivotably mounted by way of an eccentric 116 about axis 118. This enables the sideways position of the slot 110 to be varied. The radius of the slot 110 may be any value.

Figure 13 is a further variation of the Figure 12 device and is similar to the Figure 12 device except that the slot 120 on the carrier 122 is not arcuate but follows a multi radius path. To accommodate this the slider 124 includes two rotatable followers 126. Thus as the slider moves along the slot 120 it moves sideways

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relative to the cylinder axis. Movement of the slider 124 relative to the intermediate member 22 is accommodated by pivotably mounting the two together at axis 128.

Figure 14 shows a variation of the invention in which a connecting rod 130 is pivotably connected to a piston 132 and an intermediate member 134. As with all of the embodiments the intermediate member is movable sideways relative to a connector 136 mounted on the big end 138 of crank 140. The intermediate member 134 is pivotably connected to a slide member 142 at 143 which slides in slot 144 of primary carrier 146. The carrier 146 is pivotably mounted on a secondary carrier 148 at 150. The secondary carrier 148 is movable along axis 152. This axis 152 may be perpendicular to the cylinder axis or angle other than 90°. As can be seen, the intermediate member may be moved sideways so that the line 154 joining the pivot points 156 and 158 of the connecting rod lies at an angle other than 90° to the cylinder axis.

Figure 9 shows a variation of a scotch yoke device having a crank 200, connecting assembly 202 mounted on big end 204 and pistons 206 pivotably connected to intermediate member 208 by connecting rods 210. The intermediate member is constrained by frame 212 which consists of four frame members 214, 215, 216 and 217 which are pivotably mounted together. The height of the frame is the same as that of the intermediate member 208 but the frame width is greater so that sideways motion of the intermediate member 208 and hence pistons 206 is possible. The frame is movable vertically and the frame members may be pivoted to change the frame shape from a rectangle to a parallelogram. Movement of the frame vertically moves the intermediate member upwards, so causing the connecting rods 210 to pivot upwards and draw the pistons toward the centre of the device. Thus the compression ratio of the device is changed whilst the stroke remains the same.

Distortion of the frame to be non-rectangular causes the intermediate member to pivot and to follow a path at an angle to the cylinder axes. As the member moves along this path the angle between the piston and its respective connecting rod will change, resulting in a non-sinusoidal motion of the piston.

It will be apparent that many modifications and variations may be made to the embodiments described herein without departing from the spirit or scope of the invention.

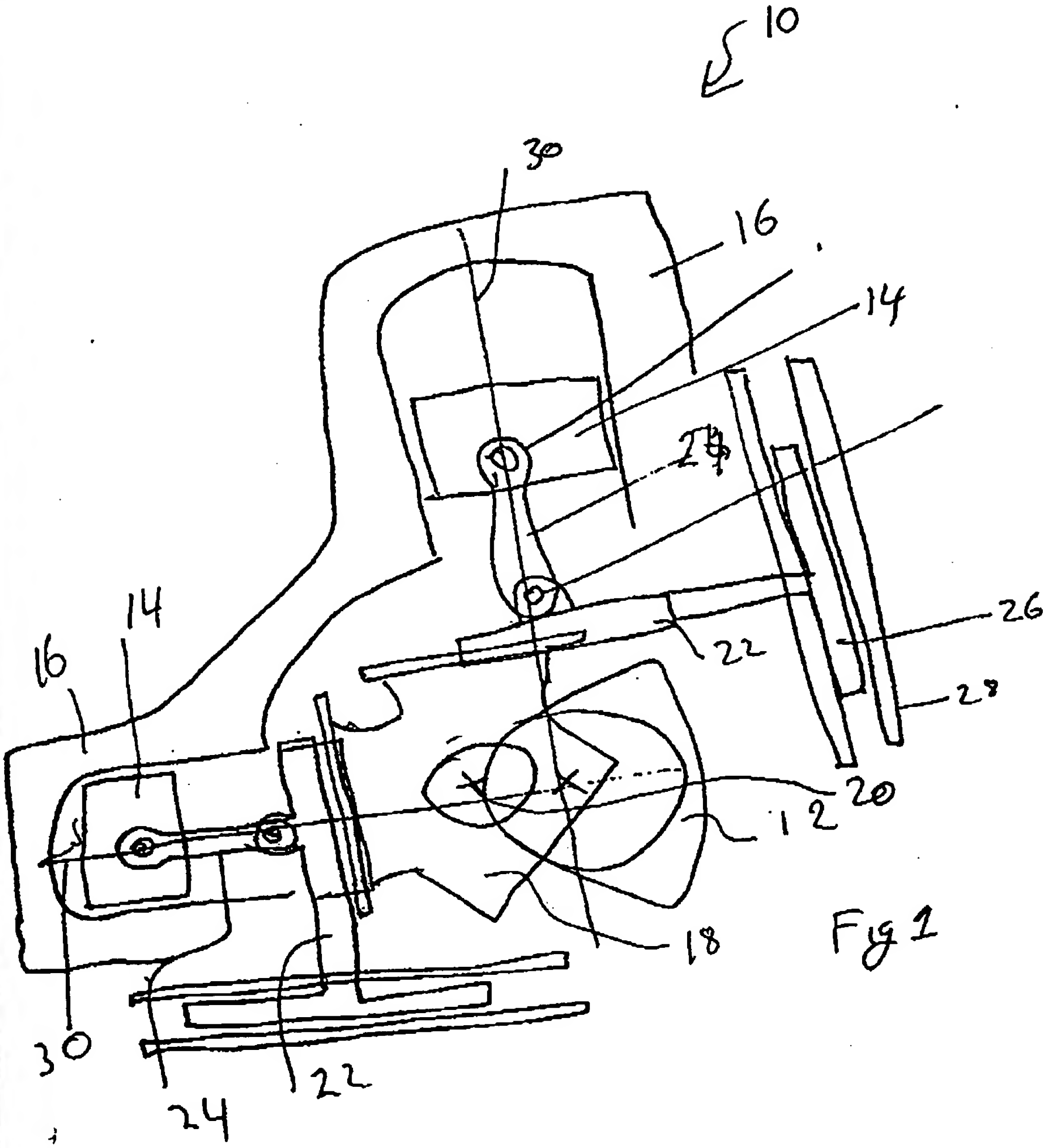

Fig 1

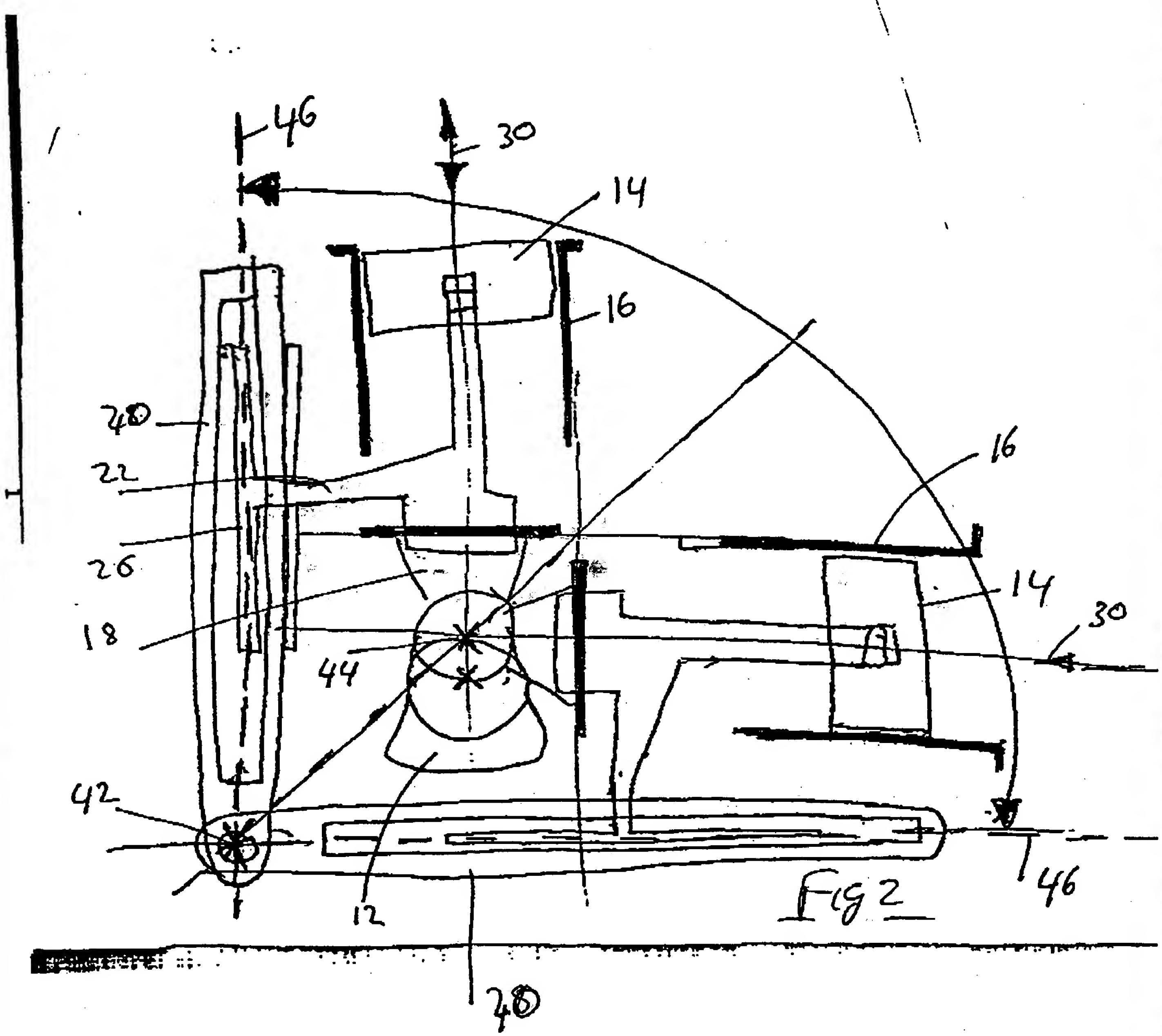

Fig 2

This invention relates to reciprocating piston fluid machines including heat engines. More particularly sinusoidal or scotch yoke type devices, we have lodged a number of specifications namely Pp9266, pp9306, pp9573, pq0287, pq0895,pq0972,pq0989, the contents of which are expressly incorparated herein. The invention has a number of uses one is a means of ensuring that too greater pressure does not develop in the variable volume chamber during the pistons stroke cycle, more particularly during the combustion phase in that cycle. This is achieved with the addition to the variable volume chamber of a displacable member, said displacable member being either part of the piston assemly or part of the cylinder wall or part of the head. The displacable member is either mechanically displaced by displacing means or it is displacable by variable volume chamber pressure (and or its "inertia" which is applicable for instance if the displacable member oscillates with the piston or is mounted in or on the piston or its parts), furthermore its motion may be controlled or modified from its potential by means of e.g damping springs, hydraulics, or other resilient member, or mechanical means or tie rod or flexible wire, friction. It is to be under stood that the displacable member may have several, motion potential, controllers or modifiers acting apon it during the operating cycle e.g the pressure of the variable volume chamber modifying the upper motion and a spring mounted twixt it and the piston or variable volume chamber parts modifying its downward motion potential. In the case of a piston mounted displacable member, the member, is in a preferred embodiment, connected to the piston or entrapped or enslaved in or on the piston, and, it is thuswise relient on the piston for its carriage, and in yet another view of this concepts utility, the piston may be a free piston. Also the member or its parts may be of a compressable or springlike or deformable nature. The member or its parts may be provided with cooling fluid/s or sump/s.

The member may be provided with sealing means and lubrication. The member in at least one embodiment may have the ability to be a once only displacable member in that the member is set to safeguard the engine from over pressuring past a critical point in an example of this the member may be crushable irrevocably for instance. Also the member may be equipped to take several or more than one combustion cycle to recover its optimun movement potential, from an over pressure situation, this allows for the variable volume chamber parts to cool for instance after an unwanted knock event or events or pinging or hydraulic lock . The member may be linked or joined to a resilient modifier by any convenient means. The member may be a portion of the piston crown, a portion within the outer circumference of the piston crown or the piston crown. The member may have means to be moved in only one direction for example away from the crank or away from the pressure, when it has moved, it can only move in that direction and when it has moved it locks to that point unless overcome by a force urging it in the same direction, overcomes the previous lock point. The invention may be used to record max pressure or max inertia. Several members may be utilised in the one variable volume chambers parts. The member or its parts may be able to project a sound or electromagnetic waveform or rays etc that is interperatable when it is more stressed, a device for hearing and interperating said sound etc could report this, and, the engine control mechanism may act apon the interperated or transmitted information to adjust the engines settings eg timing, to suit. Referring to the drawings fig 1 depicts a piston 1, a displacable member 2, a resilient motion

modifier 3, a maximun motion controller 4. Fig 4 a piston 1, a displacable member 2, a resilient modifier 44(e.g. oil resovoir or

rubber block etc), maximun motion controller 64 oil delivery gallery 19, decant or pressure overload gallery 16, pressure overload valve 16a. fig 2 a displacable member 2, piston 1, motion modifier 3, connecting means 78,77 interconnecting the displacable member 2 with the piston 1. Fig 3 piston 1, member 2, hydraulic ram 93, fluid volume 88, interconnecting means 777 connecting the piston to the member . fig 5 piston 1 displacable member 2 (spring) sealing means 54. Fig 6 member 2, piston 1, modifier 3, moyion limiter 77. Fig 8 piston 1, member 2, decantable volume 203, gallery 19 decant gallery 16. Fig 7 piston 1, member 2, modifier 7777, modifier support structure 703, motion end stop 99.

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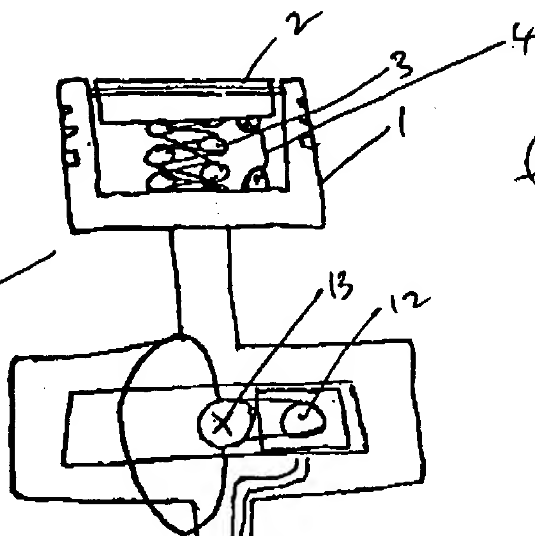

fig 1

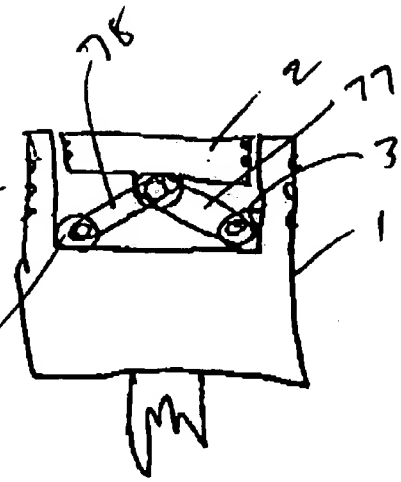

fig 2

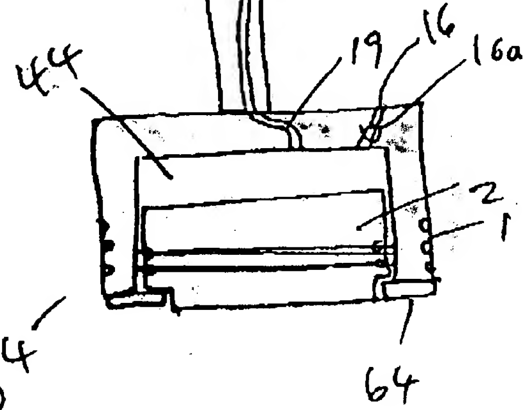

fig 4

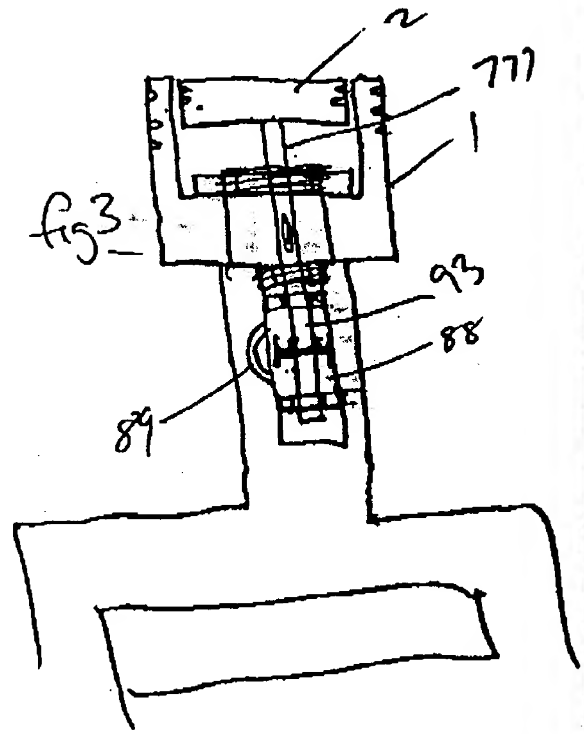

fig 3

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fig 1

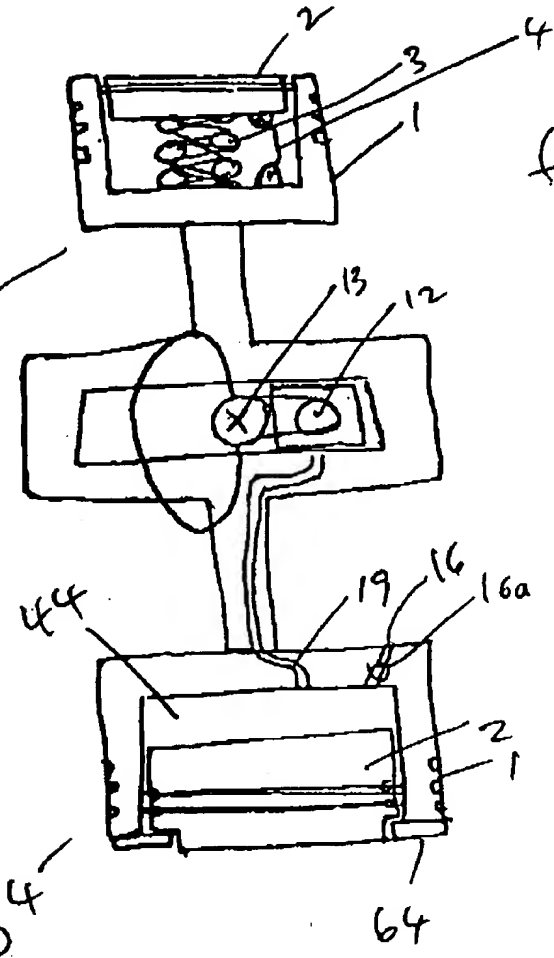

fig 4

fig 2

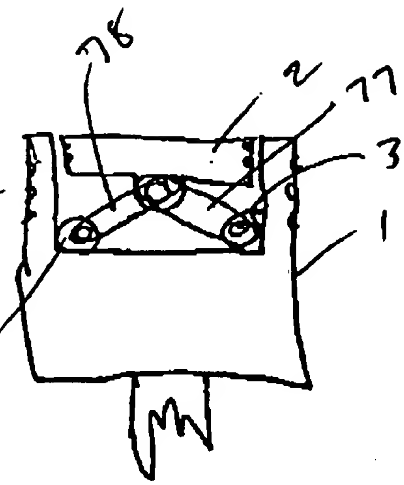

fig 3